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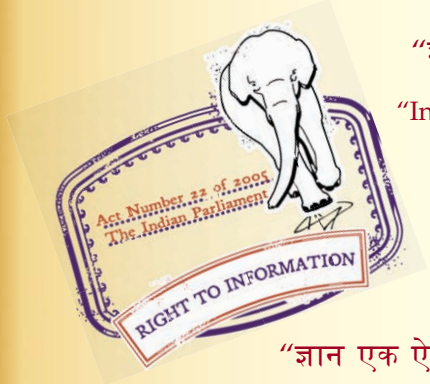
IS 7624 (1990): Lead-acid starter batteries for diesel locomotives and rail cars_ [ETD 11: Secondary Cells and Batteries]



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"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS 7624 : 1990
(Reaffirmed 2003)

भारतीय मानक

डीजल इंजनों और रेल कारों के लिए सीसा-अम्ल स्टार्टर बैटरियाँ – विशिष्टि

(पहला पुनरीक्षण)

Indian Standard

LEAD-ACID STARTER BATTERIES FOR DIESEL LOCOMOTIVES AND RAILCARS — SPECIFICATION

(First Revision)

UDC 621·355·2 : 629·422 - 843·6

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

December 1990

Price Group 7

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 14 December 1989, after the draft finalized by the Secondary Cells and Batteries Sectional Committee had been approved by the Electrotechnical Division Council.

This standard deals with the lead-acid starter batteries for diesel locomotives and railcars. It does not cover trainlighting and airconditioning batteries, which are covered by IS 6848 : 1979 'Specification for lead-acid batteries for trainlighting and airconditioning services (*first revision*)'.

Annex A describes service test for information. If this test is to be performed, it shall be agreed to between the manufacturer and the purchaser.

The revision of this standard has been taken up to align with the development at IEC level. Considerable assistance has been derived from the following:

IEC Pub 95-1 (1980) 'Lead-acid starter batteries: Part 1 General requirements and methods of test', issued by the International Electrotechnical Commission (IEC); and
IEC Doc: 21 (Central Office) 276 'Lead-acid starter batteries: Part 1 General requirements and test methods. Vibration resistance test', issued by the International Electrotechnical Commission (IEC).

The first revision includes concept of nominal reserve capacity (in time) electrolyte retention and additional functional characteristics for dry or conserved charged batteries.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

LEAD-ACID STARTER BATTERIES FOR DIESEL LOCOMOTIVES AND RAILCARS — SPECIFICATION

(First Revision)

1 SCOPE

1.1 This standard covers methods of tests, performance and other requirements of lead-acid storage batteries used as a source of energy for starting diesel engines, lighting and other normal auxiliary purposes in diesel locomotives and railcars.

2 REFERENCES

2.1 The Indian Standards listed in Annex B are necessary adjuncts to this standard.

3 TERMINOLOGY

3.0 For the purpose of this standard, the definitions given in IS 1885 (Part 8) : 1986 in addition to the following, shall apply.

3.1 Nominal Reserve Capacity (In Time)

It is the period during which a battery can supply a fixed current down to a specified end voltage.

3.2 Battery Unit

A number of cells assembled in a monoblock container.

3.3 Battery

Two or more battery units connected in series.

3.4 Type Tests

Tests carried out to prove conformity with requirements of this standard. These are intended to prove the general quality and design of a given type of battery.

3.5 Acceptance Tests

Tests carried out on samples selected from a lot for the purpose of verifying the acceptability of the lot.

3.5.1 *Lot*

All the batteries for the same type, design and rating, manufactured by the same factory during the same period using the same process and materials offered for inspection at a time shall constitute a lot.

4 GENERAL REQUIREMENTS

4.1 General

4.1.1 The requirements of batteries for different diesel locomotives and railcars as specified in Annex C shall be applicable.

4.1.2 The battery shall be able to supply for the specified engine, initial cranking current and rolling load current to crank the diesel engine of the locomotive as specified in Annex C. The battery shall also be able to supply control and lighting loads specified for the respective locomotive for a period of not less than six hours.

5 MATERIALS AND CONSTRUCTION

5.1 General

All materials used shall be free from flaws and defects and shall conform to the relevant Indian Standards, wherever applicable. The workmanship shall be in line with good engineering practice. There shall be no impurities harmful to the performance or life of the battery.

5.2 Container and Lid

5.2.1 The battery unit shall be assembled in a monoblock rubber or plastic container conforming to IS 1146 : 1981.

NOTE — Other types of containers may be used if agreed to between the manufacturer and the purchaser.

5.2.2 *Cell Lids*

Cell lids shall be either drop-on type together with suitable rubber gasket or of deep-sealing type suitable for use with bituminous sealing compound, with close fitting terminal post outlets and with vent-holes suitable for accommodating filling plug/vent plug. The vent plug and float guide dia shall be 27 mm with pitch thread of 3 mm as per IS 4218 : 1976.

5.2.3 Each cell shall be provided with a suitable separator guard, adequately secured to prevent damage to separators while inserting thermometers or service apparatus into a cell.

5.3 Separator

The separators shall conform to IS 6071 : 1986.

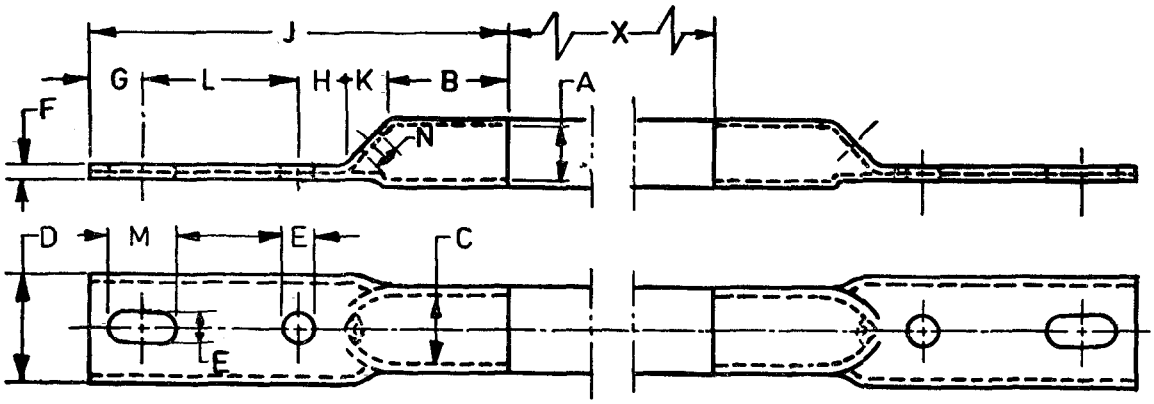
5.4 Venting Device

The venting device shall be of the anti-splash type and shall allow the gases to escape freely but shall effectively prevent acid particles or

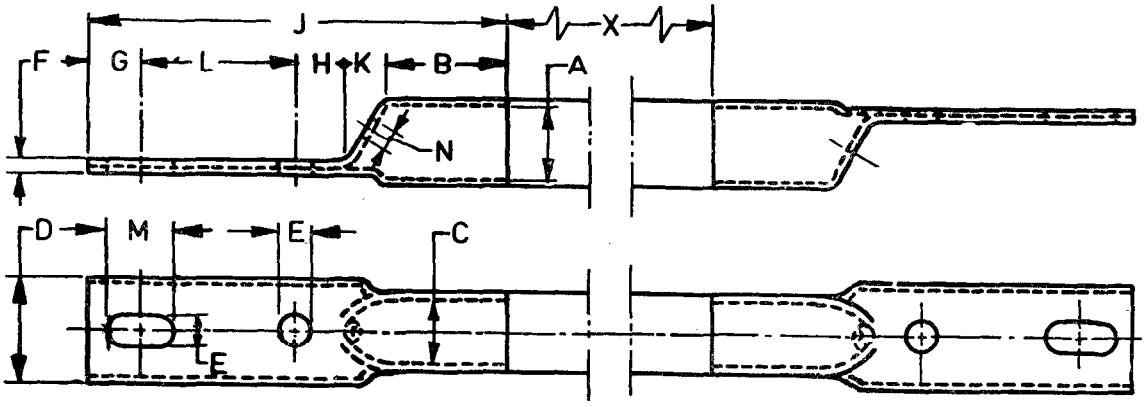
spray from coming out. Provision shall be made for drawing electrolyte samples, checking and servicing of the electrolyte.

5.5 Terminal Posts Connections

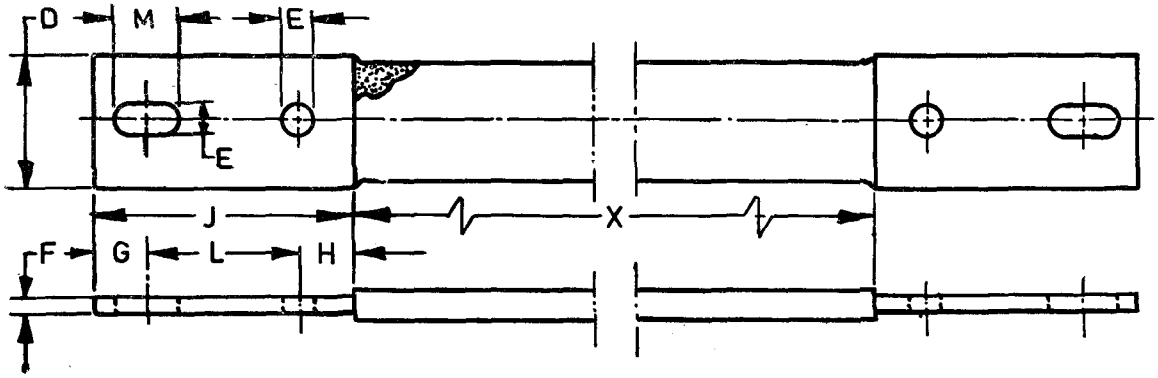
5.5.1 Each battery unit shall be provided with terminal for inter unit connection and the terminal connection of batteries shall be as given in Fig. 1. Braided type of connection (Types *C* and *F* of Fig. 1) should be used only where the cable type connection (*see* Types *A*, *B*, *E* and *G* of Fig. 1) cannot be accommodated.



TYPE A

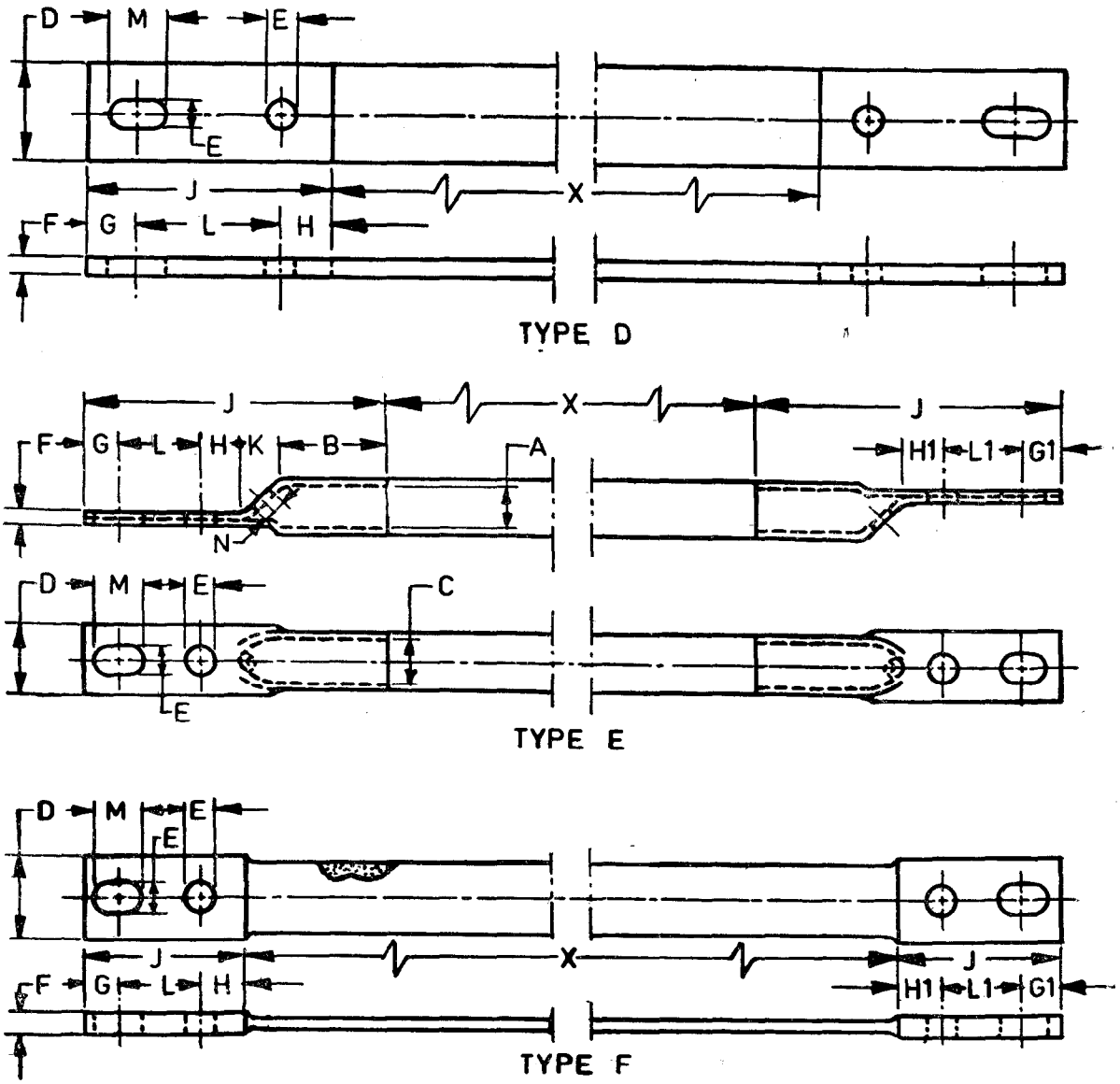


TYPES B AND G



TYPE C

FIG. 1 INTER UNIT CONNECTORS OF DIESEL LOCOMOTIVE BATTERIES (*Continued*)



Connector Type	Area mm²	Cable Size	A ±0·2	B	C ±0·2	D ±3	E +0·3 −0·0	F ±0·5	G ±1	G_1 ±1	H +2 −1	H_1 ±1	J ±3	K	L ±1	L_1 ±0·5	M	N	X
A	90	1 344/0·3	16	30	19·6	28	9·0	3·6	15·0	—	15	—	114	10	43·0	—	18·0	5	(Refer Table 1)
B	45	1 591/0·2	11·5	22	15	21·5	9·0	3·5	15·0	—	15	—	103	7	43·0	—	18·0	5	
C	90	—	—	—	—	41·5	9·0	8·0	15·0	—	15	—	74	—	43·0	—	18·0	—	
D	90	—	—	—	—	30	9·0	3·2	15·0	—	15	—	74	—	43·0	—	18·0	—	
E	45	1 591/0·2	11·5	22	15	21·5	9·0	3·5	12·0	13·5	12	13·5	79	7	26·0	23·0	12·0	5	
F	45	—	—	—	—	26	9·0	6·5	12·0	13·5	12	13·5	50	—	26·0	23·0	12·0	—	
G	70	2 228/0·2	14·3	26	17·1	25	9·0	2·8	15·0	—	15	—	108	8	43·0	—	18·0	5	

NOTES

1 The conductors used shall be copper conductors [*see* IS 9968 (Part 1) : 1988 Specification for elastomer insulated cables: Part 1 For working voltages up to and including 1 100 volts (*first revision*)].

2 The cable shall be crimped to suitable lug to ensure minimum electrical resistance and sufficient mechanical strength.

3 Thickness of lead coating on copper lug shall not be less than 0·075 mm.

All dimensions in millimetres.

FIG. 1 INTER UNIT CONNECTORS OF DIESEL LOCOMOTIVE BATTERIES

5.5.2 The inter-unit connector shall be one of the following types:

a) Flexible single core cables,

b) Flexible braided woven copper strips, and

c) Flexible copper strips.

5.5.2.1 Inter-unit connector shall be suitably insulated and protected from acid fumes.

5.5.3 The type, size and number of inter-unit connectors shall be in accordance with Table 1 unless otherwise agreed to between the manufacturer and the purchaser.

5.5.4 Terminal boards, nuts and washers shall be lead coated and shall be in accordance with Fig. 2.

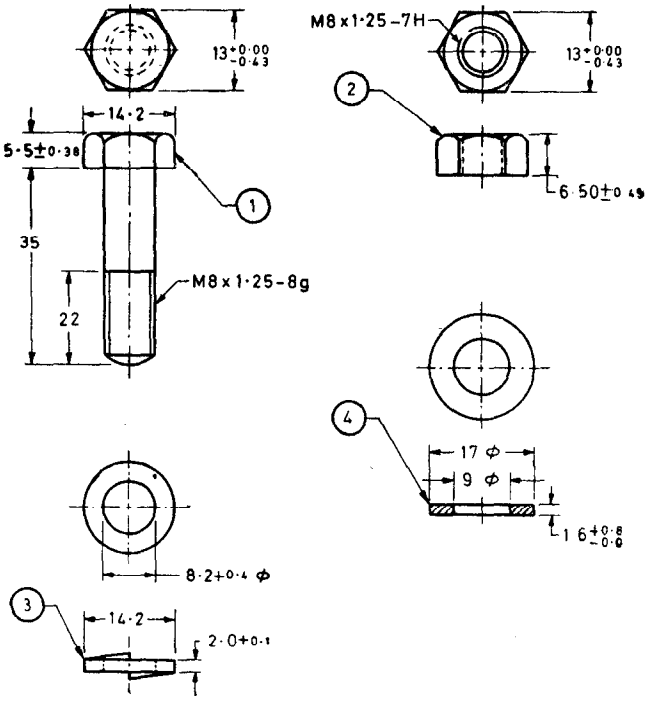
5.6 Electrolyte

5.6.1 The sulphuric acid and water used for the electrolyte and in the unit should conform to IS 266 : 1961 and IS 1069 : 1964.

5.6.2 The height of the electrolyte above the top of separators in fully topped condition shall not be less than 20 mm.

5.6.3 For the purposes of tests and service the specific gravity of electrolyte in fully charged conditions corrected to 27°C shall be between 1·240 and 1·250.

5.6.4 After a full charge, the specific gravity and temperature of the electrolyte shall be measured and the specific gravity corrected to 27°C using the formula:



Part No.	*Description*	*Material Specification*	*Material*	*Dimensional Specification*
(1)	(2)	(3)	(4)	(5)
1	Hex Bolt M8 × 35 – IS : 1363†	IS : 1367*	Free cutting steel	IS : 1363†
2	Hex Nut M8 – IS : 1363†	IS : 1367*	Free cutting steel	IS : 1363†
3	Spring Washer A 8 – IS : 3063§	IS : 4072‡	Spring steel or EN 42 steel	IS : 3063§
4	Punched Washer as IS : 2016¶, steel	IS : 513‖	Cold rolled steel, dead soft	IS : 2016¶

NOTE – Thickness of lead components shall not be less than 0·01 mm. After lead coating, threads of nut and bolt shall not transgress the maximum material limits for position H or h referred in IS : 4218**.

*Technical supply conditions for threaded fasteners (*second revision*).

‡Hexagon head bolts, screws and nuts of product grade C.

†Specification for steel for spring washers (*first revision*).

§Specification for single coil rectangular section spring washers for bolts, nuts and screws (*first revision*).

‖Cold rolled low carbon steel sheets and strips (*third revision*).

¶Specification for plain washers (*first revision*).

**ISO metric screw threads.

All dimensions in millimetres.

FIG. 2 TERMINAL BOLTS, NUTS AND WASHERS FOR INTER UNIT CONNECTORS

Table 1 Types, Sizes and Number of Inter-Unit Connectors for Diesel Locomotives Batteries

(*Clause* 5.5.3)

Sl No.	Type of Locomotive	Voltage		Inter-Unit Connector (*see* Fig. 1)		
		Per Unit	Per Set	Connector Type	Length *X*	No. Per Set
(1)	(2)	(3)	(4)	(5)	(6)	(7)
		V	V		mm	
i)	WDM-1	8	64	A	1 000	2
				or B	1 000	4
				C	230	4
				or D	230	4
				or B	230	8
				or A	230	4
ii)	WDM-2	8	64	A	400	1
				or B	400	2
				C	230	4
				or D	230	4
				or B	230	8
				or A	230	4
iii)	WDM-4	8	64	6	400	6
iv)	YDM-3 YDM-5	6	66	F	230	9
				or E	230	9
v)	YDM-4	8	64	G	1 000	4
				C	230	2
				or D	230	2
				or B	230	4
				or G	230	2
vi)	YDM-4A	8	64	G	400	2
				C	230	4
				or B	230	8
				or G	230	4
vii)	WDS-4 WDS-5	6	24	A	230	3
viii)	WDS-1	8	64	E	200	7
ix)	WDS-2	6	24	—	—	—
x)	YRD-4	8	24	—	—	—

NOTE — General tolerance on length of cable shall be ±5 mm.

$$SG_{27} = SG_t + 0{\cdot}000\ 7\ (t - 27)$$

where

SG_{27} = specific gravity at 27°C,

SG_t = specific gravity at t°C, and

t = temperature of the electrolyte (*see* Annex D).

5.7 Sealing Compound

Sealing compound, if bitumen based, shall conform to IS 3116 : 1965.

5.8 Overall Dimensions and Weight

The main dimensions and weight of each unit shall not exceed the values given in Annex C.

6 RATING

6.1 The rating assigned to the battery shall be the capacity expressed in ampere-hours (after correction to 27°C) stated by the manufacturer to be obtainable when the battery is discharged at the 10-hour rate in accordance with **7.6**.

7 TESTS AND PERFORMANCE

7.1 Classification of Tests

7.1.1 *Type Tests*

The tests given in **7.1.1.1** shall constitute the type tests.

NOTE — The battery shall be covered by type approval certificates from an appropriate authority. Significant variations in the design shall be covered by separate type approval certificates. The battery of new design shall be proto-type tested for which samples offered by the manufacturer shall be accepted. For type test, samples drawn from mass production at random shall be retested after 5 years. In case of unsatisfactory performance of batteries type testing can be repeated earlier at the discretion of the approving authority.

7.1.1.1 For type tests, six units of each type of battery shall be drawn at random and tests

shall be conducted in the sequence as indicated in the schedule given below:

Schedule of Type Tests

Test	Battery Unit Number					
	1	2	3	4	5	6
a) Physical examination (*see* 7.4)	X	X	X	X	X	X
b) Air-pressure test (*see* 7.5)	X	X	X	X	X	X
c) Rated Ah capacity test at 10-hour rate (*see* 7.6)	X	X	X	X	X	
d) Ah and Wh efficiency test (*see* 7.7)			X	X		
e) Internal resistance (*see* 7.8)			X	X		
f) Initial cranking current (*see* 7.9)	X	X				
g) Sustained cranking current (*see* 7.10)	X	X				
h) Test for retention of charge (*see* 7.11)			X	X		
j) Test for resistance to overcharge (*see* 7.12)			X	X		
k) Life test (*see* 7.13)	X	X				
m) Storage test (*see* 7.14)						X
n) Electrolyte retention test (*see* 7.15)					X	
p) Vibration resistance test (*see* 7.16)					X	

NOTE — The batteries shall be covered by a type approval certificate from an appropriate authority. All variations in design shall be covered by separate type approval certificate.

7.1.1.2 If any of the samples fail in the relevant type test, the testing authority may call for fresh samples not exceeding twice the original number and subject them again to the test(s) in which failure occurred. If there is any failure in the retest(s), the type shall be considered as not having passed the requirements of this standard.

7.1.2 *Acceptance Tests*

The following shall constitute the acceptance tests:

a) Initial cranking current test (*see* **7.9**);

b) Sustained cranking current tests (*see* **7.10**); and

c) Electrolyte retention test (*see* **7.15**).

7.1.2.1 *Sampling scheme and criteria for acceptance*

The number of batteries to be selected at random from the lot shall be in accordance with col 1 and 2 of the Table 2.

Table 2 Sample Size and Criteria for Acceptance

(*Clause* 7.1.2.1)

Lot Size	First Stage	Second Stage	$2n$	C_1	C_2	C_3
(1) N	(2) n	(3) n	(4)	(5)	(6)	(7)
Up to 50	2	2	4	0	1	1
51 to 300	3	3	6	0	1	1
301 to 500	5	5	10	0	2	2
501 to 1 000	8	8	16	0	2	2
1 001 and above	13	13	26	0	3	4

In order to ensure the randomness for selection random number tables shall be used (*see* IS 4905 : 1968).

The batteries selected shall be subjected to the acceptance tests in the order specified in **7.1.2.**

Each of the battery selected in the first stage in accordance with col 2 of Table 2 shall be tested for acceptance. A battery shall be declared defective if it fails in one or more of the acceptance tests. If the number of defectives is less than or equal to C_1 the lot shall be considered as conforming to the requirements of the standard. If the number of defective is equal to or greater than C_2, the lot shall be considered as not conforming to the requirements of the standard. If the number of defectives in the first stage is less than C_2 and greater than C_1, as further sample of same size as taken in the first stage shall be taken and tested. If the number of defectives in the two samples combined is less than C_3 the lot shall be considered as conforming to the requirements of this standard, otherwise the lot shall be considered as not conforming to the requirements of the standard.

7.2 Temperature for Test

Unless otherwise specified, the temperature for test shall be maintained between 20°C and 35°C.

7.3 Equipment and Instruments

7.3.1 *Voltmeter*

The voltmeter used for test shall be of an accuracy class not inferior to 1·0 in accordance with IS 1248 (Part 2) : 1985. The resistance of the voltmeter used shall be at least 300 ohms per volt.

The range of voltmeter used shall be appropriate for the magnitude of the voltage to be measured.

7.3.2 *Ammeter*

The ammeter used for tests shall have an accuracy class not inferior to 1·0 [*see* IS 1248 (Part 3) : 1983]. The range of ammeter used shall be appropriate for the magnitude of the current to the measured.

7.3.3 *Thermometers*

Thermometers with an appropriate scale shall be used for measuring temperatures, and one

division of the graduated scale shall represent at the most 1°C. The accuracy of the calibration shall not be less than 0·5°C.

7.3.4 *Hydrometer*

The specific gravity of the electrolyte shall be measured by hydrometers provided with a graduated scale, one division of which shall represent at the most 0·01 unit of specific gravity. The hydrometer shall be accurate to within ±0·01 units of specific gravity.

NOTE — The voltmeter, the ammeter and the thermometer of digital readout type of similar accuracy is preferable for testing. Chart recorders shall be used for life cycle testing.

7.4 Physical Examination

The batteries shall be examined for conformity with the requirements of **8**.

7.5 Air Pressure Test

The sealing of each cell of the battery unit shall be checked by compressed air at a pressure equal to 70 cm of water. The volume of tubes and auxiliary parts in connection with the cell under pressure shall not exceed 0·5 litre. Air pressure in the cell shall be noted 15 seconds after the supply has been disconnected and it shall not fall below 67 cm of water.

7.6 Ampere-Hour Capacity Test at 10-Hour Rate

The capacity at 10-hour rate of discharge when tested in the manner prescribed in Annex D shall be not less than the capacity declared by the manufacturer.

7.6.1 *The Nominal Reserve Capacity*

The nominal reserve capacity (in time) is specified by the manufacturer. It is the period during which a battery can supply a fixed current down to a specified end voltage.

7.7 Watt-Hour and Ampere-Hour Efficiency Test

When tested as described in Annex E, the watt-hour and ampere-hour efficiency shall be not less than 75 percent and 90 percent respectively.

7.8 Internal Resistance Test

The internal resistance when measured in the manner described in Annex F shall not be more than the value specified in Annex C for the respective class of diesel locomotives.

7.9 Initial Cranking Current Test

7.9.1 After standing on open circuit for not less than 12 hours and not more than 24 hours from the completion of a full charge, the battery unit shall be subjected to cycles of discharge at the rate of initial cranking current given in Annex C. Each discharge shall be of 15 seconds duration with an intermittent rest of 15 seconds.

7.9.2 *Recruitments*

The battery unit tested shall meet the minimum requirements specified in Table 3.

7.10 Sustained Cranking Current Test

7.10.1 After standing on open circuit for not less than 12 hours and not more than 24 hours on the completion of a full charge, the battery unit shall be subjected to a continuous discharge at the rate of sustained cranking current as given in Annex C.

7.10.1.1 This discharge may not be taken immediately after initial cranking current test but may be preceded by one C_{10} discharge.

7.10.2 *Requirements*

The battery unit tested shall meet the minimum requirements specified in Table 4.

7.11 Test for Retention of Charge

The object of this test is to determine the loss of capacity of a battery unit on open circuit during a specified period.

7.11.1 The battery unit shall be fully charged at the current specified by the manufacturer and it shall then be subjected to two consecutive capacity tests in accordance with **7.6**, the value of the initial capacity C being calculated as the mean of the two results thus obtained.

7.11.2 After a complete recharge and after cleaning of the electrolyte from the surface, the battery unit shall be left on open circuit for a period of 28 days without disturbance at a temperature of 27 ± 2°C.

7.11.3 After 28 days storage, the battery shall be discharged in accordance with **7.6**. The value of the capacity measured after storage shall be denoted by C_1.

7.11.4 After the discharge, the battery shall be fully charged at the rate recommended by the manufacturer.

7.11.5 The loss of capacity S, expressed as a percentage, shall be calculated from the formula:

$$S = \frac{C - C_1}{C} \times 100$$

7.11.6 *Requirement*

The loss of capacity calculated as in **7.11.5** shall not be more than 20 percent.

7.12 Resistance to Overcharge Test

The object of this test is to determine the ability of the battery to withstand overcharging.

Table 3 Initial Cranking Current Test

(*Clause* 7.9.2)

Initial Temperature of the Electrolyte	Discharge Current (15 s with 15 s Rest)	Minimum No. of 15 Seconds Cycles	Battery Terminal Voltage	
			Initial at 5 to 7 seconds	Final
(1)	(2)	(3)	(4)	(5)
	A	Cycles	V	V
27 ± 2°C	Col 8 Annex C	6	1·1 × *n*	8·8 × *n*

where

n = number of cells in series per battery unit.

Table 4 Sustained Cranking Current Test

(*Clause* 7.10.2)

Initial Temperature of the Electrolyte	Discharge Current	Minimum Discharge Time		Battery Terminal Voltage	
				Initial at 5 to 7 seconds	Final
(1)	(2)	(3)		(4)	(5)
	A	minute	second	V	V
27 ± 2°C	Col 9 Annex C	4	0	1·4 × *n*	1 × *n*

where

n = number of cells in series per battery unit.

7.12.1 The battery unit shall be charged continuously at a current $I = 0{\cdot}1 \times C_{10}$ amperes where C_{10} indicates the capacity of the battery unit in Ah at 10-hour rate of discharge for a period of 100 hours. Throughout this period, the battery unit shall be immersed in a tank of water whose temperature shall be maintained at 40 ± 3°C. The battery unit shall be so immersed that the top of the battery should be 25 mm above the water level in the tank. It several batteries are placed in the same tank a spacing of 25 mm shall be maintained between them and between the tank at the battery. While the battery is being charged, the level of the electrolyte shall be checked daily and maintained at a specified level by adding distilled water.

7.12.2 When the battery unit has been charged as specified in **7.12.1**, it shall be left disconnected in the tank of water at a temperature of 40 ± 3°C for a period of 68 hours. At the end of this period, the battery unit shall be discharged at the rate of sustained cranking current (col 9 of Annex C) at the temperature of 40 ± 3°C to an end voltage of 1 V × *n*, where *n* is the number of cells in series per battery unit.

7.12.3 The battery unit shall then be charged again and discharged as specified in **7.12.1** and **7.12.2** respectively. The cycle shall be repeated 6 times thereafter, that is, it shall be carried out 8 times in all. (The battery is thus subjected to a total overcharging of 80 times the rated ampere-hour capacity and to 8 checking discharges.)

7.12.4 *Requirements*

On each of the 8 checking discharges, the duration before the voltage drops to 1 V × *n* shall not be less than 3 minutes. The voltage at the end of discharge shall be recorded.

7.13 Life Test

7.13.1 Battery unit shall be subjected to 6 test units of life test as prescribed in Annex G.

7.13.2 The duration of the rapid discharge of each test unit under the conditions prescribed in **G-5** shall not be less than 3 minutes.

7.14 Storage Test

The battery units shall be capable of being stored unfilled for a period of 24 months from the date of manufacture. After storage for the specified period, the batteries shall meet the requirements of capacity test (*see* **7.6**).

7.15 Electrolyte Retention Test

The ability of a battery to retain the electrolyte in various critical positions.

7.15.1 The test is carried out on a fully-charged battery.

7.15.2 The battery is allowed to stand on open circuit for a period of 4 hours.

7.15.3 The electrolyte level in each cell is again adjusted, if necessary.

7.15.4 The battery is then charged at a current 0·1 of nominal capacity for a period of 30 minutes. All surfaces are then cleaned to remove any electrolyte.

7.15.5 The battery is then tilted in the forward, backward, and both the side directions at intervals of not less than 30 seconds between each tilting, under the following conditions:

a) The battery is tilted through 0·8 radian from the vertical during a maximum period of 1 s,

b) The battery is maintained in this position for 3 s, and

c) The battery is restored to the vertical position during a maximum period of 1 s.

7.15.6 The test carried out in accordance with **7.15.5** shall be completed within a period of 15 minutes after the termination of the charging period in accordance with **7.15.4**.

7.15.7 There shall be no electrolyte visible on the external surface of the battery or its terminals and caps.

7.16 Vibration Resistance Test

The test shall be performed in accordance with IS 9000 (Part 8) : 1981. The samples shall be first tested for capacity test at 10 hours rate before pushing into vibration test. The test consists in vibrating the batteries at a frequency of 16 Hz with a total displacement of 5 mm for a period of 2 hours. During vibration, the batteries shall be discharged at the 10 hours rate.

7.17 Requirements

There shall not be any sudden drop, either in the current or voltage values and there shall be no spillage of electrolyte during the test.

8 MARKING

8.1 Every battery unit shall have the following details marked:

a) Indication of the source of manufacture,
b) Date of manufacture,
c) Type,
d) Serial number, and
e) Specific gravity.

8.2 Manufacturer shall provide suitable space on the battery terminal lug to enable the purchaser to stamp the date of commissioning of the unit.

9 DATA FROM THE MANUFACTURER

9.1 It is recommended that the manufacturer along with the quotation or supply shall provide the information given in Annex H and Annex J.

10 MANUAL OF INSTRUCTIONS

10.1 The manufacturer shall supply one copy of the instruction manual for initial treatment and routine maintenance on service, with every batch of ten sets or a part thereof ordered.

ANNEX A

(*Foreword*)

SERVICE TEST

A-1 SERVICE TEST

A-1.1 The test is to be carried out after not less than 12 months and before 18 months from the date of supply. About 10 percent of the supply may be tested at random.

A-1.2 After standing on open circuit for not less than 12 hours and not more than 24 hours from the completion of a full charge, the battery shall be subjected to cycles of discharge by starter motor cranking the diesel engine with its full line closed. The duration of each discharge shall be of 15 seconds with an intermittent rest of 15 seconds. The battery shall be capable of performing a minimum of 15 such cycles.

ANNEX B

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
266 : 1961	Specification for sulphuric acid (*revised*)
1069 : 1964	Specification for water for storage batteries (*revised*)
1146 : 1980	Specification for rubber and plastic containers for lead-acid storage batteries (*first revision*)
1248 (Part 2) : 1985	Specification for direct acting indicating analogue electrical measuring instruments and their accessories: Part 2 Ammeters and voltmeters (*second revision*)
1248 (Part 3) : 1983	Specification for direct acting indicating analogue electrical measuring instruments and their accessories: Part 3 Wattmeters and varmeters (*second revision*)
1885 (Part 8) : 1986	Electrotechnical vocabulary: Part 8 Secondary cells and batteries (*first revision*)
3116 : 1965	Specification for sealing compound for lead-acid batteries
4218 : 1976	Specification for ISO metric screw threads
4905 : 1968	Methods for random sampling
6071 : 1986	Specification for synthetic separators for lead-acid batteries (*first revision*)
9000 (Part 8) : 1981	Basic environmental testing procedures for electronic and electrical items: Part 8 Vibration (sinusoidal) test

ANNEX C

(*Clauses* 4.1.1, 4.1.2, 5.8, 7.8, 7.9.1, 7.9.2, 7.10.1, 7.10.2, 7.12.2 *and* F-2)

DESIGN AND CONSTRUCTION

Sl No.	Class of Locomotive and Railcar	Type of Transmission	Battery Voltage	No. of Cells	Voltage of Each Battery Unit	No. of Battery Units	Initial Cranking Current	Sustained Cranking Current	Control Equipment Lighting Current	Internal Resistance per Battery Unit	Length, mm	Width, mm	Height, mm	Wt. per Battery Unit with Electrolyte	Ah Capacity at 10 Hour Rate
			V		V		A	A	A		(*l*)	(*b*)	(*h*)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	WDM1	E	64	32	8	8	2 300	1 400	45	4·7	724	225	470	160	450
	WDM2	E													
2	WDM4	E	64	32	8	8	1 500	940	35	5·5	724	210	470	130	290
	YDM4	E													
	YDM4A	E													
	WDS5	E													
3	YDM1	H	24	12	4	6	2 300	1 400	41	2·5	400	240	400	85	450
4	YDM3	E	66	33	6	11	1 100	700	35	10·0	413	181	260	75	—
	YDM5	E													
5	WDS1	E	64	32	8	8	1 000	300	15	5·0	410	190	385	95	—
6	WDS2	H	24	12	6	4	1 900	1 100	25	8·5	550	280	400	95	—
7	WDS3	H	24	12	8	3	2 300	1 400	41	4·7	724	225	470	160	—
	WDS4	H													
	NDM1	H													
	ZDM1	H													
	ZDM2	H													
	ZDM3	H													
	ZDM4	H													
8	YRD4	H	24	12	8	3	1 400	750	27	5·5	700	210	450	95	—

NOTE — E = Electric. H = Hydraulic.

ANNEX D

(*Clauses* 5.6.4 *and* 7.6)

TEST FOR CAPACITY AT THE 10-HOUR RATE

D-1 After standing on open circuit for not less than 12 hours and not more than 24 hours from the completion of a charge the battery unit shall be discharged through a suitable resistance at a current in amperes numerically equal to one-tenth of the rated ampere-hour capacity and the discharge shall be stopped when the closed circuit voltage across the battery unit terminals falls down to $1{\cdot}75 \times n$ volts, where n is the total number of cells in series in a battery unit or until the voltage across one cell has fallen down to 1·70 volts, whichever is earlier. The first measurement of this voltage shall be made 5 to 7 seconds after the beginning of the discharge.

If, however, a test discharge cannot be conducted within the specified rest period due to any exigencies, a freshening charge may be given to the cell/battery at the finishing rate of charge recommended by the manufacturer for a period of 1 hour after every 24 hours or part thereof, of extended rest period. The capacity test, however, can be started after a minimum period of two hours elapsing after this freshening charge.

D-2 At this rate of discharge, hourly voltage readings may be taken until the battery unit voltage approaches $1{\cdot}80 \times n$ volt after which the readings shall be taken every 15 minutes.

D-3 On the first discharge, the battery shall give not less than 85 percent the rated capacity C_{10} and the rated capacity shall be reached within 10 discharge cycles subsequent to the initial charge.

NOTE — If the capacity is reached in the first discharge, no further discharge shall be conducted.

D-4 The battery unit shall be charged at a rate recommended by the manufacturer, immediately after each discharge.

D-5 The capacity in Ah shall be obtained by multiplying the discharge current by the total time of discharge in hours and the product so obtained shall be corrected to a temperature of 27 ± 2°C by applying the following formula:

$$C_{27}°C = \frac{C_t°C}{1 + k\,(t - 27)}$$

where

k = 0·004 3 for tubular positive plates and pasted positive plates,

$C_{27}°C$ = Ah capacity at an average electrolyte temperature of 27°C,

$C_t°C$ = Ah capacity obtained at an average electrolyte temperature of t°C, and

t = average temperature of electrolyte during discharge (mean value of initial and final temperature).

ANNEX E

(*Clause* 7.7)

PROCEDURE FOR MEASURING AMPERE-HOUR AND WATT-HOUR EFFICIENCY

E-1 The following method for determining the maximum ampere-hour and watt-hour efficiencies shall be used:

a) *Ampere-Hour Efficiency*

A fully charged battery unit shall be discharged at $I = 0{\cdot}1 \times C_{10}$ ampere to a voltage of $1{\cdot}75 \times n$ volts, careful measurements being made of the exact number of ampere-hours delivered. On the recharge, the same number of ampere-hours are put back at the same current. A second discharge shall then be made to the same cut-off voltage as before. The efficiency of the battery unit is then calculated as the ratio of the ampere-hour delivered during the second discharge corrected to 27°C to the ampere-hour put in during the charge.

b) *Watt-Hour Efficiency*

The watthour efficiency shall be calculated by multiplying the ampere-hour efficiency by the ratio of average discharge and recharge voltages shall be calculated from the long sheets for ampere-hour efficiency.

ANNEX F

(*Clauses* 7.8 *and* H-1)

PROCEDURE FOR MEASURING INTERNAL RESISTANCE

F-1 The battery unit shall be charged at the normal charging rate. After charging, the battery unit shall be discharged for one hour at 10-hour rate.

F-2 The test shall be continued by increasing the discharge current to approximately equal to 1·5 times the value specified in col 10 in Annex C (A_1) and after an interval not exceeding 5 minutes, the current shall be decreased to half the value specified in col 10 in Annex C (A_2).

The current A_1 and A_2 in amperes and the corresponding battery units terminal voltages V_1 and V_2 in volts, shall be measured simultaneously.

The internal resistance expressed in milliohm of the battery units under test shall be calculated from the formula given below:

$$R = \frac{(V_2 - V_1)\ 1\,000}{(A_1 - A_2)}\ \text{m}\Omega$$

F-3 The internal resistance may also be measured by a direct reading meter if agreed to between the manufacturer and the purchaser.

ANNEX G

(*Clause* 7.13.1)

LIFE TEST

G-1 The life of battery unit is defined by the number of life-test-units obtained under the following conditions.

G-2 The life test is carried out on at least two batteries which have satisfactorily passed the tests in accordance with **7.4**, **7.5**, **7.6**, **7.9** and **7.10**.

G-3 The battery is to be fully charged. When fully charged, the level and specific gravity of the electrolyte of each cell shall be checked and, if necessary, adjusted.

G-4 The batteries shall then be subjected to a series of discharges and charges continuously. The discharge shall be completed in 1 hour at an average current of $I = 0{\cdot}035 \times$ sustained cranking current. The charging shall be effected during 5 h at an average current of $I = 0{\cdot}035 \times$ sustained cranking current. Throughout the life-test-unit, the batteries shall be immersed in a tank of water, the temperature of which is maintained at 40 ± 3°C. The batteries shall be so immered that their top surface shall be not more than 25 mm above the water level in the tank. If several batteries are placed in the same tank, a distance of 25 mm shall be maintained between them. The distance between the batteries and the sides of the tank shall also be 25 mm. Distilled or de-ionized water shall be added to the cells daily during the life test to maintain the electrolyte at its normal level.

G-5 After the last charge of series of 36 discharge-charge cycles, the batteries shall be disconnected from the circuit. They shall then remain on open circuit for 96 hours. After this open circuit stand, they shall be discharged at the rapid rate I, sustained cranking current. This discharge is continued down to an end voltage of I V $\times$ n. On completion of this discharge, the batteries shall be fully recharged at normal rate. The combination of 36 discharge (and charge cycles as described above together with 96 hours open circuit period, the checking discharge rapid discharge) and the subsequent recharge together constitute one complete unit of life test.

G-6 After the final life test, the battery shall not be subjected to any test.

ANNEX H

(*Clause* 9.1)

INFORMATION TO BE PROVED BY MANUFACTURERS AT THE TIME OF ENQUIRY AND SUPPLY

H-1 The following design particulars are required to be supplied by the manufacturer along with the quotation or supply:

a) Make .....
b) Type of unit .....
c) Manufacturer's nomenclature .....
d) Overall dimensions of battery unit length × width × height ..... mm
e) Weight per battery unit with electrolyte ..... kg
f) Cell container material .....
g) Type of positive plates .....
h) Type of negative plates .....
j) Type of separator .....
k) Maximum electrolyte temperature that the cell/battery with withstand without any damage
   1) Continuously ..... °C
   2) For a short period ..... °C
m) Electrolyte height above the top of the separator ..... mm
n) Clearance between plates and bottom of the container ..... mm
p) Quality of electrolyte per cell ..... litre
q) Specific gravity of electrolyte for initial filling at 27°C .....
r) Details of initial treatment recommended .....
s) Material of terminal and inter-unit connector .....
t) Internal resistance of 27°C (measured according to Annex F) ..... m
u) Normal charging rate ..... ampere

ANNEX J

(*Clause* 9.1)

RECOMMENDED PROFORMA FOR TYPE APPROVAL CERTIFICATE

J-1 Batteries offered according to this standard shall be covered by a type approval certificate from an appropriate authority. All variations in design shall be covered by separate type approval certificate. Following particulars regarding the type tests shall be supplied by the manufacturer along with the certificate against any quotation or supply:

a) Air pressure test (*see* **7.5**)	cm of water
b) Capacity test (*see* **7.6**)	Ah
c) Ah and Wh efficiency test (*see* **7.7**)	Percent
d) Internal resistance test (*see* **7.8**)	mΩ
e) Initial cranking current test (*see* **7.9**)	Initial volts — number of cycles
f) Sustained cranking current tests (*see* **7.10**)	Initial value — min.s duration
g) Retention of charge test (*see* **7.11**)	Percent loss
h) Resistance to overcharge test (*see* **7.12**)	Number of cycles volts at the end of last cycle Units
j) Storage test (*see* **7.14**)	Ah
k) Discharge curves with voltage as ordinate (scale 10 mm to 1 volt) and time as abscissa (scale 30 mm to 1 hour) are to be supplied showing the performance of the cells under the following conditions:	
1) Discharge of battery units/batteries at 10-hour rate	
2) Discharge of battery units/batteries at the initial cranking current	
3) Discharge of battery units/batteries at the sustained cranking current	

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The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

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